

**Table 4-2.** Monitoring of CFA groundwater wells.

| Contaminant of Potential Concern    | Number of Wells Monitored<br>(a maximum of 41) |
|-------------------------------------|--|
| <b>Radionuclide Contaminants</b>    |  |
| Am-241                              | 16   |
| Cs-137                              | 31   |
| H-3                                 | 41   |
| I-129                               | 27   |
| Pu-238                              | 16   |
| Pu-239                              | 1  |
| Pu-240                              | 16   |
| Sr-90                               | 35   |
| U-234                               | 5  |
| U-235                               | 6  |
| U-238                               | 5  |
| <b>Nonradiological Contaminants</b> |  |
| 1,2-Dichloroethane                  | 39   |
| Aroclor-1254                        | 0  |
| Aroclor-1260                        | 0  |
| Arsenic                             | 41   |
| Benzaldehyde                        | 0  |
| Beryllium                           | 40   |
| Cadmium                             | 39   |
| Chloromethane                       | 40   |
| Chromium                            | 40   |
| Mercury                             | 39   |
| Phenol                              | 7  |
| TPH-gasoline                        | 0  |
| TPH-diesel                          | 0  |
| Trichloroethene                     | 40   |
| Zinc                                | 31   |

COPC concentrations were tabulated along with established background groundwater concentrations, maximum contaminant levels (MCLs), and risk-based concentrations in Tables G-22 through G-24, respectively. Risk based concentrations were obtained from the WAG 4 OU 4-13 RI/FS Work Plan (McCormick, et al, 1997). These tables were constructed based on the following assumptions: (1) if duplicate samples were taken, the highest concentration is tabulated; (2) if one of the samples indicated the presence of a constituent and the duplicate sample did not, the positive sample was plotted and the nondetect was disregarded; (3) a positive detection for a radionuclide is a concentration that equaled or exceeded 2 sigma (95% confidence limit based on the uncertainty); (4) if no background groundwater concentration had been established for a specified constituent, zero was used as the background value and any positive detection was classified as a concentration above background levels and; (5) all data with "u" data flags were considered zero and all data with "r" data flags were considered unusable. Radionuclides with sample concentrations that were less than 2 sigma were considered to be non-detected. Radionuclide concentrations that are less than 2 sigma are considered statistically "non-positive."

Trend analyses and concentration contour diagrams for the COPCs for which sufficient data are available are illustrated in Burgess (1998). The concentrations used for contouring were predominately from 1995 to 1997. The data used to construct the concentration diagrams is also provided in Burgess (1998). The concentration contour diagrams include the regional area (maximum of 41 wells) around the RWMC and a separate set that consists of concentrations obtained from wells at CFA.

**4.3.1.2.1 1,2-Dichloroethane**—1,2-Dichloroethane is widely distributed in the environment at trace concentrations because it is used predominately as a solvent in industrial, agricultural, and household products. The MCL for 1,2-Dichloroethane is 5 ug/L. 1,2-Dichloroethane is not naturally occurring and true background concentrations should be zero. Knobel, et al. (1992) suggest that background concentrations of 1,2-dichloroethane in water from the Snake River Plain aquifer is less than 0.2 ug/L. A total of 39 wells in the regional area near CFA were monitored for 1,2-dichloroethane. Only 2 wells indicated a positive detection. The only well at CFA which reported a positive detection was well CFA-1 (0.6 ug/L). The other positive detection was from well M7S (0.8 ug/L), located down the hydraulic gradient near RWMC. See Table G-1 for a summary of all collected 1,2-dichloroethane data from the 41 wells. Both of these wells have had additional sampling since the 1993 positive detection in which concentrations were below the detection level. Both of these positive samples were above the background and risk-based concentrations (0.3 ug/L, risk= $10^{-6}$ ). However, neither of these concentrations were above the MCL of 5 ug/L.

**4.3.1.2.2 Americium-241**—The risk-based concentration for Am-241 is 0.145 pCi/L ( $10^{-6}$  risk). The MCL for Am-241 is 6.34 pCi/L. Am-241 is anthropogenically present in groundwater as a fission product of nuclear weapons tests and as a result of disposal practices in the nuclear industry. Therefore, the true background is not zero, however, Knobel et al., (June 1992) states that the background concentration in the SRPA is essentially zero. The only possible site at CFA from which Am-241 was released is the STP drainfield. Am-241 was generated at two CFA facilities that laundered radioactively contaminated protective clothing. The effluent from these facilities was discharged to the drainfield. The total activity of Am-241 discharged to the drainfield is estimated at  $9.3 \text{ E-}03 \text{ Ci}$  (McCormick 1997).

Sixteen of the 41 monitor wells in the regional vicinity of CFA have been measured for Am-241. In general, only the USGS wells are measured for this contaminant. All of the monitored wells are located upgradient of CFA, except for well M7S which is located near RWMC. However, only 11 of these 16 wells have been monitored for Am-241 since 1994. Four of the 16 wells tested for Am-241 have had a single positive detection each. These samples were collected in 1994–1995. The maximum concentration is from well USGS 112, located near INTEC, contained 0.21 pCi/L. All 4 of these wells are located upgradient of CFA. Several wells at ARA and PBF have positive detections from gross alpha

samples in both soil and groundwater, indicating the possible presence of Am-241. However, no wells at CFA have been monitored for Am-241, therefore, the extent of contamination is not known.

Samples from these 41 wells have not exceeded the MCL for AM-241. Only the single sample from USGS 112 exceeded the risk based concentration. All 4 samples collected from USGS 34, 36, 39, and 120 exceeded the background concentration for Am-241.

Groundwater model predictions from the WAG 3 RI/FS (Schafer et al., 1996) indicate that the maximum aquifer Am-241 concentration at INTEC was 0.91 pCi/L in 1986. However, because of the slow decay rate and high Kd value, the concentrations in the aquifer are expected to decline slowly. In the year 2095, the predicted maximum Am-241 aquifer concentration is 0.63 pCi/L which is still higher than the  $10^{-6}$  risk concentration and less than the MCL. After 2095, the concentrations continue to decline and are predicted to fall below the  $10^{-6}$  risk level after the year 2500. During that time period, the aquifer area above the  $10^{-6}$  risk concentration is limited to the areas in the vicinity of INTEC. Based on the model results (Schafer et al., 1996), the concentration contours which exceed the MCL and risk based concentration near INTEC do not affect the area near CFA. However, no wells in the area near CFA have ever been monitored for Am-241.

The only possible site at CFA from which Am-241 was released is the STP drainfield. Am-241 was generated at two CFA facilities that laundered radioactively contaminated protective clothing. The effluent from these facilities was discharged to the drainfield. The total activity of Am-241 discharged to the drainfield is estimated at 9.3 E-03 Ci (McCormick 1997).

**4.3.1.2.3 Arsenic**—The MCL for arsenic is 50 ug/L. The background concentration for arsenic is 2 to 3 ug/L (Orr et al., 1991). The risk based concentration for arsenic is 0.05 ug/L (risk =  $10^{-6}$ ).

Arsenic is regularly monitored in wells near CFA and several USGS wells between INTEC and CFA. Arsenic has been analyzed in all of the 41 wells in the vicinity of CFA. Most of these samples have been collected since 1986. All of these wells have detected arsenic in at least one sample, indicating that arsenic is a widespread contaminant in the SRPA in the vicinity of CFA.

Trend analysis indicates that wells LF3-08, LF3-09, LF3-10, CFA-1, CFA-MON-A-001, CFA-MON-A-002, LF2-08, LF2-10, LF2-11 and USGS 85 reflect increasing concentrations since 1995-96 (Burgess 1998). However, the trend for most of these wells consists of only 3–5 samples collected in this time period.

None of the 41 wells contained concentrations of arsenic above the MCL. However, 25 wells had at least one sample with a concentration above background. All of the 41 wells contained at least one sample with a concentration above the risk based concentration. The highest concentrations from these wells were detected in well M7S (4.8 ug/L), located near RWMC, STF-MON-A-01A (3.4 ug/L) and -02A (3.8 ug/L), located near ARA, and USGS 112 (3.3 ug/L), located immediately south of INTEC. These findings suggest that arsenic is widely distributed in the aquifer near CFA and that there are source(s) contributing to the groundwater upgradient of CFA. However, the source(s) of this contaminant which affects concentrations at CFA is not distinguishable using present data.

Groundwater model predictions from the WAG 3 RI/FS (Schafer et al., 1996) indicate that arsenic concentrations in the aquifer never exceed the MCL. Model predictions simulated contaminant transport from the present time through the year 2995. Arsenic peak risk concentrations ( $10^{-6}$ ), originating from INTEC, affect the CFA in the year 2095 through 2955. The  $10^{-6}$  risk based concentration is exceeded throughout this time period in the CFA area. Examination of the vadose zone peak concentration and

mass flux to the aquifer suggests that the concentration of arsenic in the aquifer will decrease very slowly, and that it will remain above the risk based concentration for at least through the year 3095 near INTEC.

**4.3.1.2.4 Beryllium**—The MCL and risk based concentration for beryllium is 4 ug/L and 0.2 ug/L, respectively. No background concentration for beryllium has been established for the SRPA. Forty of the 41 wells in the vicinity of CFA have been sampled at least once for beryllium. Most of the wells at CFA are regularly monitored for beryllium while the other wells away from the facility are not.

Of the 40 wells sampled for beryllium, only 4 wells have detected this constituent. These wells include M7S, located near the RWMC, wells CFA-1, LF2-08, and LF2-09, which are all located at CFA. Well M7S is the only well in which beryllium was detected on more than one occasion. This well has had a total of 12 nondetects and 3 detects. All of the positive beryllium detections at the CFA wells were collected during the same sampling event (6/93).

Due to the fact that beryllium is not continuously monitored in most of the wells located outside of CFA inconsistent positive detections, and positive detections in both soil and groundwater near ARA and PBF, the location of the source area(s) to the groundwater is not apparent.

**4.3.1.2.5 Cadmium**—The MCL for cadmium is 5 ug/L and the background concentration in the SRPA is <1 ug/L (Orr et al., 1991). The risk-based concentration for cadmium is 20 ug/L (risk HI=1)

Thirty-nine in the vicinity of CFA have been sampled for cadmium at least once. Most of the wells at CFA are regularly (quarterly) monitored for cadmium. Eighteen of these wells have produced at least one sample with concentrations above the MCL. Nineteen wells have had at least one sample with concentrations above the background level. Well LF2-11 (located at CFA) is the only well to have a concentration (120 ug/L) above the risk based concentration. During the collection of this sample from well LF2-11. A duplicate sample from this well contained a concentration of 93 ug/L.

Trend analysis indicate all of the wells in the vicinity of CFA have decreasing cadmium concentrations since 1995 (Burgess, 1998). Most of the wells at CFA were installed and began the long term monitoring programs initiated in 1993.

Many of the wells at CFA have both filtered and unfiltered samples for cadmium. The analytical data from filtered samples collected from these wells are nondetect while the unfiltered samples had positive detections. Also, validation of the data indicated that many of the duplicate analyses were outside of analytical control limits. The inconsistency in the data suggests that the results are possibly false positives or potential anomalies.

Based on the available data, it is apparent that cadmium is wide spread throughout the south-central portion of the INEEL. Data collected during the OU 4-12 Landfills project appear anomalous and samples from wells located outside of CFA are not consistently analyzed for cadmium. Also, cadmium has been detected soil and groundwater above background levels, at INTEC, TRA, (both facilities are located upgradient) and CFA. Cadmium was also detected in soil samples from ARA, located cross-gradient from CFA. Cadmium concentrations above background levels are also present at the RWMC, located down-gradient from CFA. It is unlikely that a source of cadmium exists at CFA due to the wide distribution in the soil and groundwater.

**4.3.1.2.6 Chloromethane**—The MCL for chloromethane has not been established. The risk based concentration is 6.55 ug/L. Chloromethane is not naturally occurring in the environment; therefore, the true background concentration should be zero.

Forty wells in the vicinity of CFA have been sampled at least once for chloromethane. All of the wells at CFA and several wells immediately downgradient of INTEC are regularly analyzed for chloromethane. However, chloromethane has not been detected in these wells. Well M7S is the only well, out of the 40 wells, which has ever had a positive detection. The duplicate sample collected at the time of this detection did not contain a concentration above the detection limit. Well M7S has also had 16 non-detects. Therefore, based on the available data, chloromethane does not appear to be present in the groundwater at CFA, nor within the regional area around CFA.

**4.3.1.2.7 Chromium**—Historically, chromium primarily has been used at the INEEL for cooling tower operations. In 1972, chromium was replaced as a corrosion inhibitor by a polyphosphate. Chromium also is naturally occurring in the SRPA as a component of basaltic magmas. Chromium is found in spinels in the olivine-rich inclusions of basaltic rocks (Deer, Howie, and Zussman, 1967). The background concentrations of chromium in water from the SRPA generally range from about 2 to 3 ug/L (Orr, Cecil, and Knobel, 1991). The MCL for total chromium is 100 ug/L. The risk based concentration is 200 ug/L (risk = HI = 1).

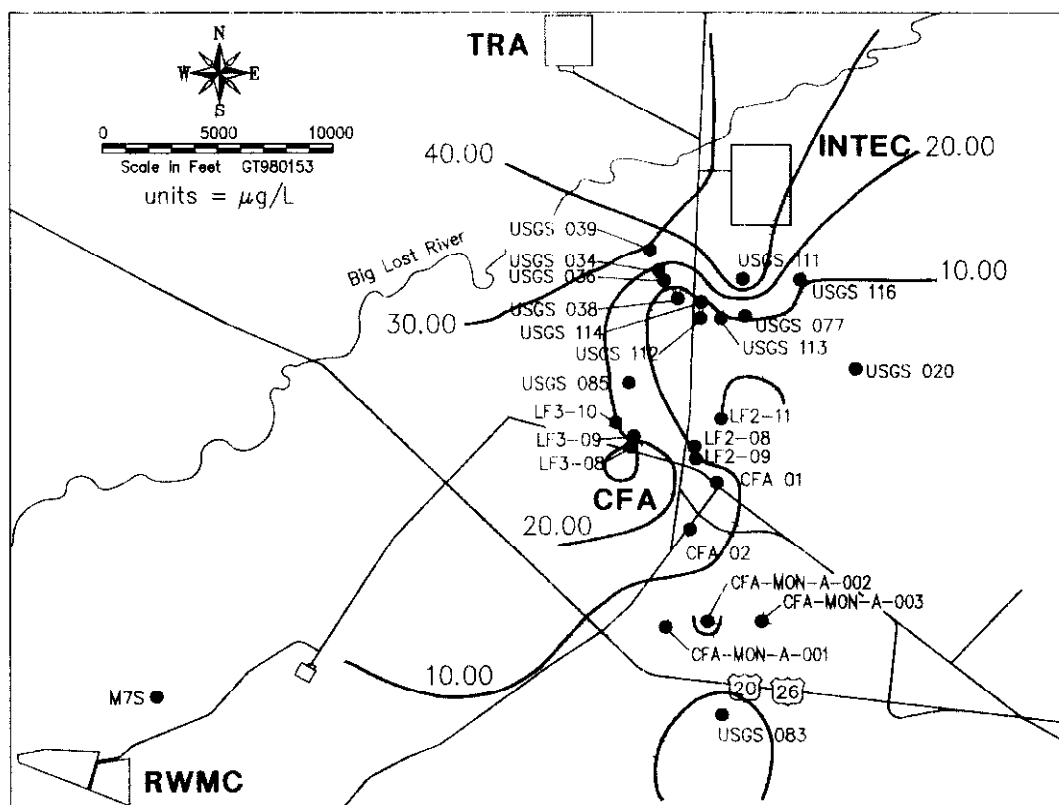
All of the 41 wells in the vicinity of CFA have been sampled for chromium at least once. Most of these wells are monitored regularly for chromium. Well CFA-MON-A-003 is the only well where chromium was not detected above the detection limit. Also, all of these wells have chromium concentrations above background concentrations. However, none of these 41 wells have ever had a concentration above the MCL or risk based concentration.

Trend analysis indicate the following wells have increasing concentrations of chromium since sampling began in 1993; CFA-2, LF 3-09, and LF 3-10, (Burgess, 1998). The following USGS wells have increasing concentrations since 1976; USGS 20, 34, 35, 36, 37, 39, 85, 106, 111, and 116 (Burgess, 1998). These wells are located up and downgradient from CFA, indicating chromium concentrations are increasing throughout the area south of INTEC/TRA.

Groundwater concentration contours indicate chromium concentrations are high near INTEC and decrease downgradient toward CFA and RWMC (Figure 4-32). These data indicate that chromium is directly attributable to past waste disposal practices at INTEC and probably TRA, located upgradient of CFA. Another source of chromium in samples was stainless steel pumps, manufactured in part with high-chromium stainless steel, which contributed to chromium concentrations during 1989–90. These pumps were replaced with other pumps constructed with non high-chromium metals during the OU 4-12 RI/FS and chromium detections dropped accordingly.

The documented disposal of chromium at upgradient facilities TRA and INTEC, and their measurable effect on concentrations of chromium in the aquifer indicate that potential source(s) at CFA are nonexistent or overshadowed by concentrations from these upgradient sources. Also, one explanation for the higher concentrations of chromium in the landfill wells at CFA in 1989 and 1990 are due to type of pumps previously used.

Groundwater model predictions from the WAG 3 RI/FS (Schafer et al., 1996) indicate that chromium concentrations, originating from TRA and INTEC, do not affect the CFA area above the MCL or risk based concentrations. Their model predictions indicated that most of the chromium reaching the aquifer resulted from past disposal practices at the TRA facilities. The chromium in the INTEC vicinity originates primarily as a result of contaminated soils which should be currently bound in the vadose zone sediments. Schafer et al. (1996) suggests that the INTEC contribution of chromium is predicted to reach the aquifer in levels of 1/100<sup>th</sup> the MCL after year 2020 near INTEC. They also state that the maximum concentration in the aquifer should have occurred during the 1966–1971 time period and that this peak occurs in the TRA area. Chromium concentrations in the aquifer fell below and remains below the HI=1



**Figure 4-32.** 1995–1996 chromium concentrations in the Snake River Plain aquifer near CFA. Concentrations in ug/L.

risk level in 1984, and remains below the MCL by 2003 in the TRA area only. Due to the groundwater flow direction, most of the chromium in the aquifer from TRA remains west of CFA.

**4.3.1.2.8 Cesium-137**—The MCL for cesium-137 is 200 pCi/L. The background concentration in the SRPA has not been established. The risk based concentration is 1.51 ( $10^{-6}$  risk) pCi/L.

Thirty-one of the 41 wells in the vicinity of CFA have been sampled at least once for cesium-137. The only well in which Cs-137 has been detected is CFA-2. This sample was collected October 1987 and had a concentration of 60 pCi/L. The only other sample from this well was collected five years earlier and cesium-137 was not detected. The only well at CFA which is regularly sampled for cesium-137 is LF2-10. This well has been sampled 7 times since November 1994 with no detections of cesium-137. USGS wells, located between INTEC and CFA, are regularly sampled (since 1994) for cesium-137.

Groundwater model predictions from the WAG 3 RI/FS (Schafer et al., 1996) indicate that cesium-137 concentrations, originating from INTEC, do not affect CFA above the MCL or risk based concentration. These model predictions simulated contaminant transport from 1959 through 2227.

**4.3.1.2.9 Iodine-129**—The MCL for iodine-129 is 1 pCi/L. The background levels in the SRPA are 0.05 pCi/L (Orr et al., 1991). The risk based concentration for iodine-129 is 0.295 pCi/L ( $10^{-6}$  risk).

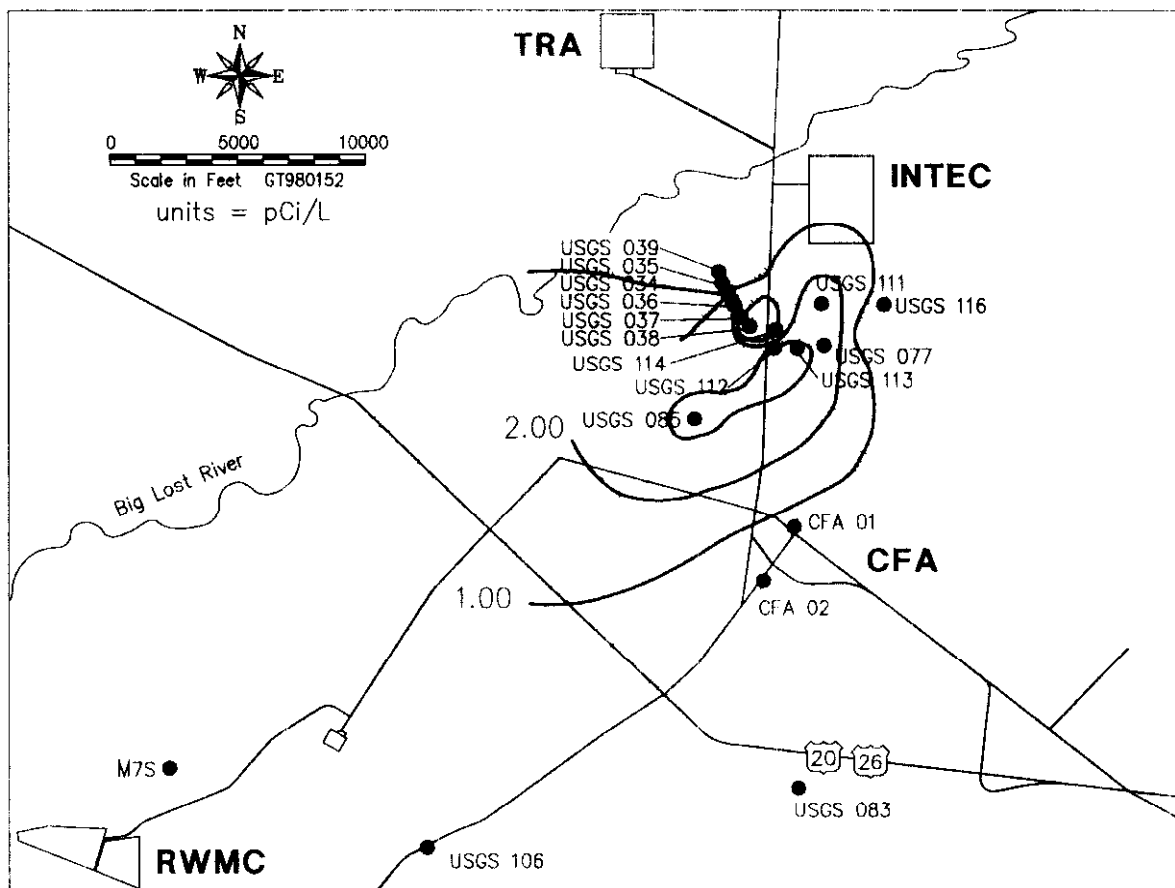
Twenty-seven in the vicinity of CFA have been sampled for iodine-129. Iodine-129 was detected on 17 of the 27 wells at least once during their sampling history. Wells at CFA which iodine-129 was

detected are CFA-1, CFA-2, LF2-12, and LF3-09. The remaining wells with positive detections for iodine-129 are located between INTEC and CFA. Most of these wells have been sampled only 3–5 times over the past 10–15 years, therefore trend analyses are not very meaningful.

The only well at CFA with iodine-129 above the MCL is LF2-12. This well was sampled in June 1995, and is the only sample analyzed for iodine-129 from this well. Well M7S, located near the RWMC, is the only well downgradient from CFA/INTEC where iodine-129 was detected above the MCL. The remaining 9 wells where iodine-129 was detected above the MCL are located between INTEC and CFA.

The concentrations are above background at 16 of the 17 wells where iodine-129 was detected. Four of these 16 wells are located at CFA; CFA-1, CFA-2, LF2-12, and LF3-09. Fourteen of the 17 wells contain concentrations above the risk based concentrations. Three of these wells are located at CFA, CFA-1, LF2-12, and LF3-09.

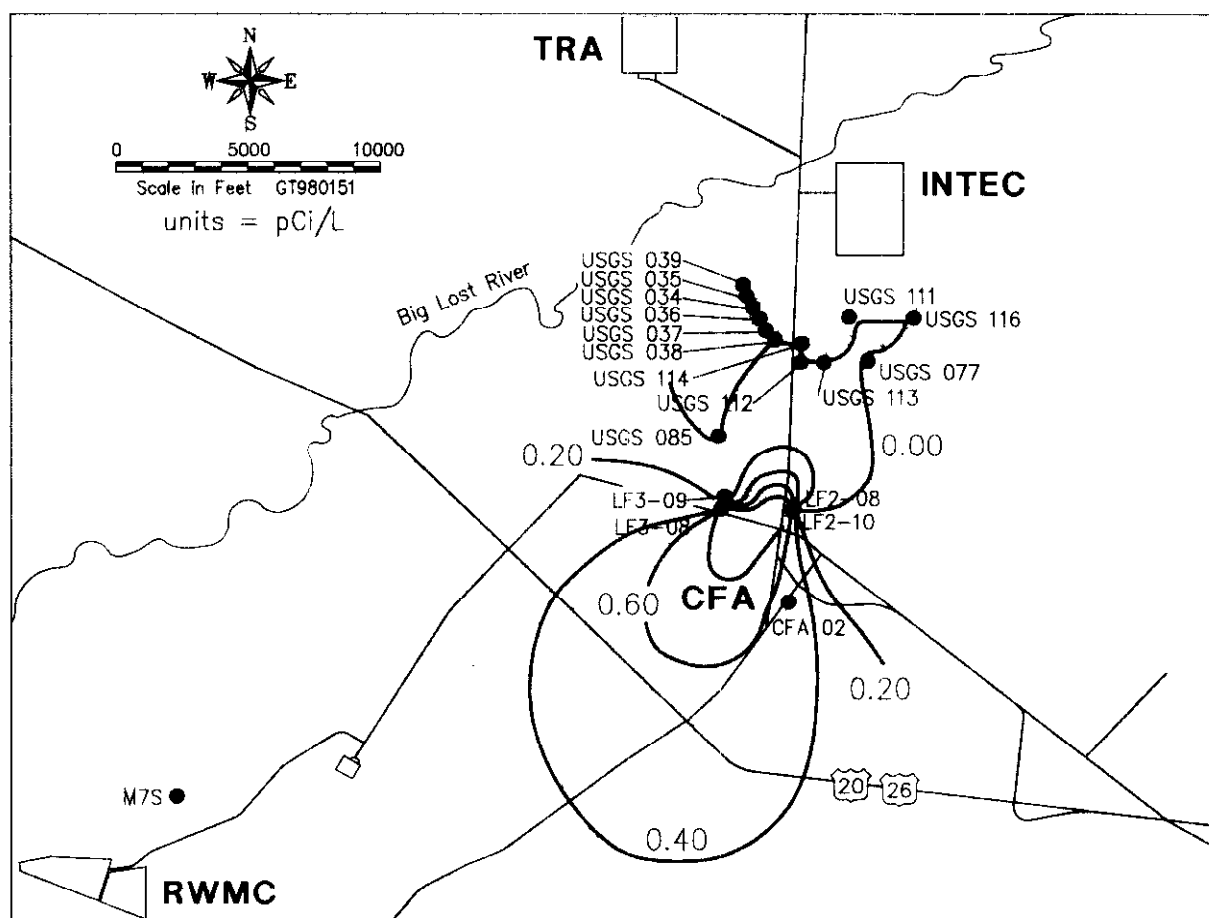
Iodine-129 concentration diagrams from 1986 indicate that the wells between INTEC and CFA contain the higher concentrations (Figure 4-33). However, using 1995 data, most of those same wells between INTEC and CFA indicate no detects or small concentrations of iodine-129 while the wells at



**Figure 4-33.** 1986 iodine-129 concentrations in the Snake River Plain aquifer near CFA.

CFA have the higher concentrations (Figure 4-34). These figures imply that the bulk of the iodine-129 contamination has moved downgradient from the INTEC area. The source of I-129 is believed to be an injection well formerly used at INTEC. However, it is difficult to directly compare these figures because the landfill wells (9 wells total) at CFA were not installed until 1990.

Groundwater model predictions from the WAG 3 RI/FS (Schafer et al., 1996) indicate that iodine-129 peak concentrations are greater than the MCL and  $10^{-6}$  risk-based concentration. However, the predicted concentrations are greater than measured concentrations. Contour diagrams illustrate that concentrations above the MCL and risk based level will affect the CFA area from 1959 (model prediction began) through 2939 (model prediction ended). However, field measurements on this order have not been recorded. Schafer et al., (1996) suggest the lower recorded concentrations could be indicative of (1) I-129 being absorbed both in the aquifer and vadose zone interbed material or (2) a much larger source term than actually exists at the vadose zone surface. The first possibility would result in (a) transport being much slower than predicted; (b) measured water concentrations being lower than predicted; (c) a strong possibility that field measurements of iodine-129 are recording the mass disposed of into the injection well as opposed to the mass predicted that should arrive from the vadose zone; and (d) iodine-129 being sorbed in the alluvium rather than already having been transported to the top of the basalt unit. The second possibility would result in overall lower concentrations arriving from the vadose zone to the aquifer within the time frame predicted by this model parameterization.



**Figure 4-34.** 1995 iodine-129 concentrations in the Snake River Plain aquifer near CFA. Concentrations in pCi/L.



Schafer et al., (1996) stated that comparisons of their aquifer model predicted concentrations to field data show that predicted concentrations are above measured values in all cases and appear to predict earlier arrival of iodine-129 in the wells than actually observed.

**4.3.1.2.10 Mercury**—The MCL for mercury is 5 ug/L. Background concentrations in the SRPA are 0.1 ug/L (Orr et al., 1991). The HQ=1 based concentration is 3.65 ug/L.

Mercury was analyzed for at least once in 38 wells in the vicinity of CFA and almost all of these wells are regularly sampled for mercury. Data collected from twelve of the 38 wells indicate detections of mercury in at least one sample. Four of the 12 wells are located at CFA; CFA-1, LF2-08, LF2-12, and LF3-08. However, concentrations in these wells have never exceeded the MCL or risk-based concentration. Six of the 12 wells are located between INTEC and CFA. The “badging facility” well, located southeast of CFA, has detected mercury in one sample collected August 1985. Well M7S, located downgradient near the RWMC, has had mercury detected on two sampling occasions. Nine of the 12 wells have concentrations above background levels. Three of these wells are located at CFA, while the majority are located between INTEC and CFA.

Trend analysis indicate the only well with an increasing mercury concentration through time is LF2-12 (Burgess, 1998). A total of four samples have been analyzed for mercury from this well. In 1993 mercury was not detected in three samples. However, in June 1995 a sample containing 0.44 ug/L was collected from this well. Overall, the other 11 wells in which mercury has been detected in the past indicate concentrations of mercury in the vicinity of CFA are decreasing. During the two sampling periods in 1996 and 1997 the only well in which mercury was LF2-08 (0.1 ug/L). This concentration is at background levels for the SRPA.

Groundwater model predictions from the WAG 3 RI/FS (Schafer et al., 1996) indicate that mercury concentrations, originating from INTEC, would not affect the CFA area at levels above MCL or risk based concentrations. The model predictions simulate contaminate transport from the year 1959 through 2118. Schafer et al., (1996) also states that because the simulations were terminated before the bulk of the mass had left the vadose zone at INTEC, the concentrations in the aquifer are the result of mercury discharged into the injection well and from dispersion downward from the soil sources. The overall maximum mercury concentration in the aquifer is  $7.42 \times 10^{-3}$  mg/L with the peak concentration in 2095 equal to  $4.17 \times 10^{-3}$  mg/L at INTEC. If the vadose zone simulations had been run out another several thousand years, the mercury in the vadose zone at INTEC would eventually reach the aquifer. However, the simulation was stopped before the concentrations dropped below the MCL and HQ=1 based concentration. Schafer et al., (1996) indicates this was justified because the aquifer contour plots illustrate that the mercury source will remain beneath INTEC and slowly decrease in concentration primarily as a result of dispersion. The most likely source of mercury as a result of injection at INEEL. The only possible source of mercury at CFA would be landfill 2. However, disposal records indicate only 2 kg of mercury was disposed to the landfill.

**4.3.1.2.11 Phenol**—The MCL for phenol has not been established. Phenol does not naturally occur in the SRPA, therefore the true background should be zero. The HQ=1 based concentration is 0.003 ug/L.

Seven wells in the vicinity of CFA have been sampled for phenol. Six of the wells are located between INTEC and CFA. These six wells are USGS wells and have been sampled once for phenol in 1995. Phenol was not detected in the wells. None of these wells detected phenol above the detection limit. Well M7S is the only other well within the vicinity of CFA which has been sampled for phenol. This well is regularly monitored for phenol and has been sampled a total of 10 times since 1992. Phenol

has not been detected in well M7S. No wells at CFA are sampled for phenol, therefore it is difficult to determine if phenol is present in the groundwater at CFA. Also, coupled with the infrequent sampling of wells upgradient of CFA, it is difficult to determine if phenol is present and where these source area(s) are located. However, the limited data suggests that phenol is probably not widespread throughout the SRPA near CFA/INTEC.

**4.3.1.2.12 Plutonium-238**—The MCL for plutonium-238 is 7.02 pCi/L. The background level in the SRPA have not been established. The risk based concentration is 0.161 pCi/L ( $10^{-6}$  risk).

Sixteen wells in the vicinity of CFA have been sampled for plutonium-238 at least once. Data indicate that four of the 16 wells have plutonium-238 above the detection limit. The only well located at CFA is CFA-1 and the only well that has had two detections of plutonium-238. The other three wells; M7S, located near RWMC, USGS 37 and 112, located between INTEC and CFA, have had one positive detection each.

Monitoring wells at CFA are not regularly sampled for plutonium-238. Wells USGS 37 and 77 are the only two wells that are regularly sampled for plutonium-238. Both of these wells are located upgradient from CFA.

Trend analysis for plutonium-238 indicate that well CFA-1 had two positive detections in 1987 and two nondetects in 1988 (Burgess, 1998). This well has not been analyzed for plutonium-238 since the samples collected in 1988. Well M7S had one positive detection in 1993 and three nondetects in 1996 and 1997. Well USGS 37 has had 12 nondetects since 1982 prior to the positive detection in 1995.

Well USGS 112 has had a sampled result above the risk-based concentration for plutonium-238. This sample was collected in October 1994 and the well has since had one sample collected in May 1995 which was a nondetect. None of the 41 wells in the vicinity of CFA have had sample results with concentrations above the MCL.

Groundwater model predictions from the WAG 3 RI/FS (Schafer et al., 1996) indicate that total plutonium in the SRPA, originating from INTEC, will substantially affect groundwater concentrations at CFA in the future. The model prediction simulated from 1972 through the year 3804. The predicted maximum aquifer concentration at the end of the simulation time is 35.1 pCi/L which exceeds the  $10^{-6}$  risk concentration but not the MCL (62 pCi/L for total plutonium). Schafer et al., (1996) predictions indicate that the aquifer area with predicted maximum concentrations greater than the  $10^{-6}$  risk concentration is very large by the year 2095. At this time in the simulation, the plutonium concentration affecting the CFA area is at the  $10^{-7}$  risk level. The  $10^{-6}$  risk concentration will affect the area at CFA between the years 2227 and 2775. Concentrations in the aquifer continue increasing to above the  $10^{-5}$  risk concentration between the years 2775 and 3322.

Schafer et al., (1996) state that the concentration of plutonium in the vadose zone at INTEC will never drop below the  $10^{-6}$  risk concentration or fall below the MCL in the time period simulated (through the year 3800). By the year 2095, only 2% of the mass had left the vadose zone, and although still above the  $10^{-6}$  risk level in 3815, the simulations were terminated with only 38% of the mass having left the vadose zone.

Schafer et al., (1996) state that their model predictions did not include plutonium-238 within the total plutonium because it was assumed that it was not present in the source inventory. They suggest that the absence of plutonium-238 in the source inventory was a data gap. Plutonium-238 was reported in some contaminated soil but not in the major INTEC sources.

**4.3.1.2.13 Plutonium-239**—The MCL for plutonium-239 is 62.1 pCi/L. The background concentration in the SRPA is not established. The  $10^{-6}$  risk based concentration is 0.151 pCi/L.

One well located in the vicinity of CFA has been sampled for plutonium-239. Three samples from well M7S located downgradient of CFA were analyzed for plutonium-239 from June 1996 through April 1997 and all have been below the detection limit. Wells located between INTEC and CFA have not been analyzed for plutonium-239. Therefore, it is not known; if the SRPA beneath CFA contains plutonium-239 and the potential source(s) of this contaminant.

Groundwater model predictions from the WAG 3 RI/FS (Schafer et al., 1996) indicate that total plutonium in the SRPA, originating from INTEC, will substantially affect groundwater concentrations at CFA in the future. The bulk of their activity used to calculate the total plutonium was plutonium-239. The following was used as the total plutonium activity distribution in their model; 60.3% plutonium-239, 30.0% plutonium-240, 9.6% plutonium-241, and 0.04% plutonium-242. These model simulations predict that total plutonium concentrations at CFA will not significantly be affected until approximately 2095. At this time total plutonium levels will exceed the  $10^{-7}$  risk levels. See Section 4.3.1.2.12 for additional information on plutonium model simulations in the SRPA.

**4.3.1.2.14 Plutonium-239/240**—The MCL for plutonium-239/240 is 62.1 pCi/L. The background concentration in the SRPA has not been established. The  $10^{-6}$  risk concentration is 0.151 pCi/L.

Sixteen wells in the vicinity of CFA have been sampled for plutonium-239/240 at least once. Two of the 16 wells have indicated the presence of plutonium-239/240 above the detection limit. These wells include M7S, located near RWMC and USGS 112, located between INTEC and CFA, have had one positive detection each. The plutonium-239/240 levels were not above the MCL, however the risk-based concentration was exceeded.

Monitoring well at CFA are not regularly monitored for plutonium-239/240. Wells USGS 34, 37 and 38 are the only three wells out of the 41 which are regularly sampled for plutonium-239/240. All of these wells are located between INTEC and CFA.

Groundwater model predictions from the WAG 3 RI/FS (Schafer et al., 1996) indicate that total plutonium in the SRPA, originating from INTEC, will substantially affect groundwater concentrations at CFA in the future. The following was used as the total plutonium activity distribution in their model; 60.3% plutonium-239, 30.0% plutonium-240, 9.6% plutonium-241, and 0.04% plutonium-242. These model simulations predict that total plutonium concentrations at CFA will not significantly be affected until approximately 2095. At this time total plutonium levels will exceed the  $10^{-7}$  risk levels. See Section 4.3.1.2.12 for additional information on plutonium model simulations in the SRPA.

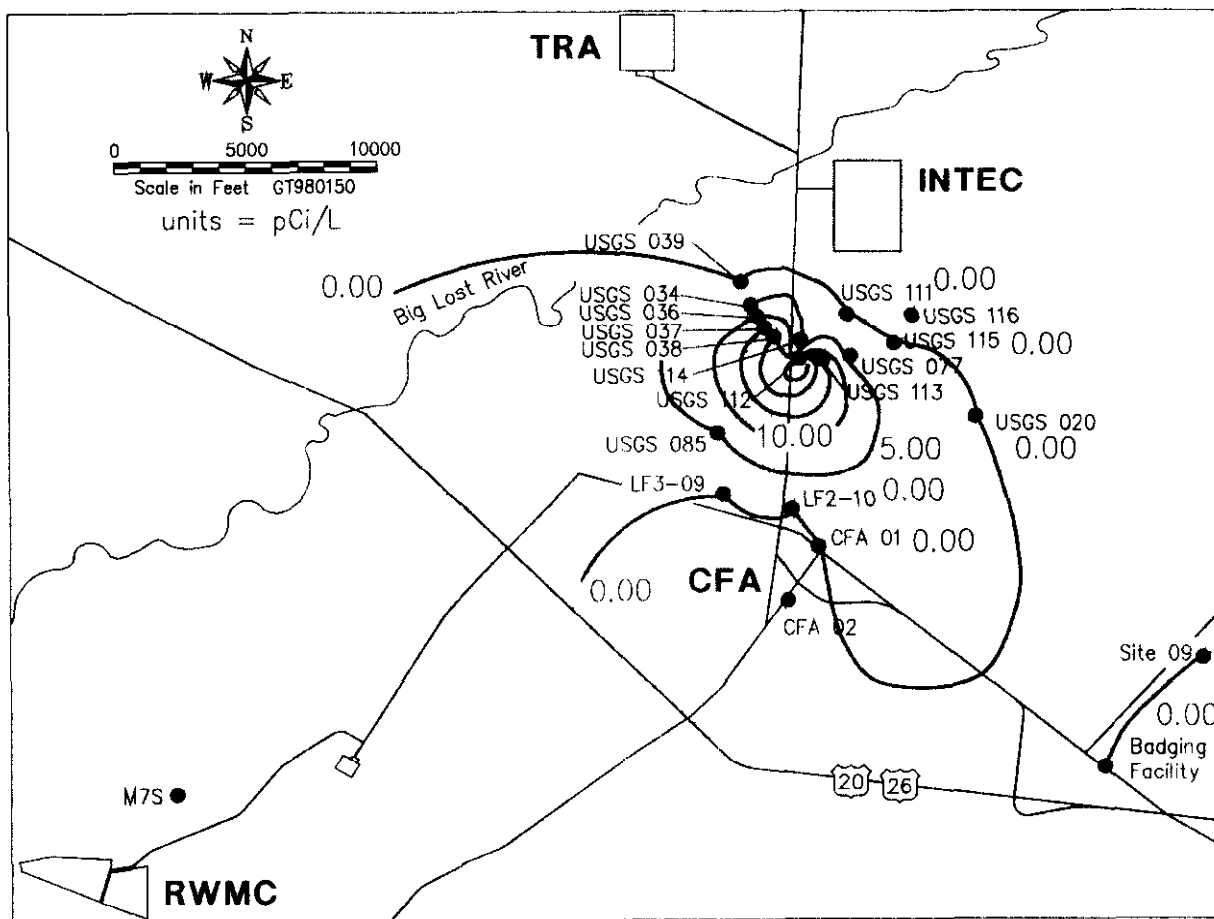
**4.3.1.2.15 Strontium-90**—The MCL for strontium-90 is 8 pCi/L and the background level in the SRPA is 0.05 pCi/L (Orr et al., 1991). The  $10^{-6}$  risk based concentration is 0.852 pCi/L.

Thirty-five of the 41 wells in the vicinity of CFA have been sampled at least once for strontium-90. Data indicate that twenty of the 35 have detected strontium-90. Six of the 20 wells are located at CFA, M7S is located near RWMC, and the remaining 13 wells are located between INTEC and CFA.

Four wells including; CFA-1, CFA-2, LF2-10, and LF3-09 are regularly monitored for strontium-90 at CFA. Fifteen wells, located between INTEC and CFA, are regularly monitored for strontium-90.

Strontium-90 trend analysis indicate that wells M7S, located near RWMC, USGS 35, 36, 37, 38, and 116, all located between INTEC and CFA have increasing concentrations throughout their sampling history (Burgess, 1998). However, only two of these wells indicate increasing concentration trends since 1990. Those wells having increasing concentrations since 1990 include M7S, USGS 34, 85, and 116. Most of the wells immediately downgradient from INTEC that have been regularly monitored for strontium-90 since the early 1960s have peaked in concentration ranging from the late 1960s to mid 1980s.

Groundwater contour concentration diagrams for 1996 strontium-90 concentrations indicate the highest Sr-90 concentrations occur in wells located immediately downgradient from INTEC (Figure 4-35). The lack of strontium-90 in wells located at CFA indicates the lack of source(s) contributing this contaminant to the aquifer at the present time. Also, groundwater model predictions from the WAG 3 RI/FS (Schafer et al., 1996) indicate that strontium-90 concentrations originating from INTEC would not significantly affect wells at CFA until approximately 2025.



**Figure 4-35.** 1996 strontium-90 concentrations in the Snake River Plain aquifer near CFA. Concentrations in pCi/L.

Schafer et al., (1996) suggest that model simulations for strontium-90 concentrations indicate that the overall highest concentration at INTEC was predicted to have been 920 pCi/L in 1967. However, their model predictions indicate that strontium-90 concentrations near the  $10^{-7}$  risk level will not occur until approximately 2025. The  $10^{-7}$  risk concentrations will remain in the aquifer at CFA until between 2172 and 2227. The  $10^{-6}$  risk concentrations will closely approach the CFA area in 2095.

Schafer et al., (1996) state that if Kds used in the model are correct, the field measurements of strontium-90 taken in this decade should be a reflection of the mass disposed to the injection well, and not the arrival of strontium-90 from the vadose zone. However, strontium-90 moves slowly with a Kd of  $24 \text{ km}^3/\text{g}$  but it decays rapidly with a half life of 29.1 years. As a result, much of the strontium-90 source decays while still resident in the vadose zone. Strontium-90 releases to the aquifer from the vadose zone occurs from 1990 through 2300, peaking in 2058, and tailing slowly off after the percolation ponds are removed in 2095. Model predictions also show that the peak concentration reaches a value of 348 pCi/L in 2227, but never falls below the  $10^{-6}$  risk concentration in the vadose zone. Although still above the  $10^{-6}$  risk level in 2227, the simulations were terminated because 95.8% of the initial mass in place had either entered the aquifer or decayed and because the concentrations entering the aquifer were less than risk based limits.

Modeling efforts, groundwater data, and trend analysis all indicate the significant source of strontium-90 located at INTEC. It is possible that sites at CFA contribute strontium-90 to the aquifer, however these concentrations are minimal compared to those originating from upgradient sources.

**4.3.1.2.16 Trichloroethene**—Trichloroethene commonly is used as a dry-cleaning fluid, an extraction solvent for oils, a refrigerant and heat exchange liquid, a diluent in paints and adhesives and to degrease and dry metals and electric parts. The MCL for trichloroethene is 5 ug/L and the risk based concentration is 7.74 ug/L ( $10^{-6}$  risk). Trichloroethene is not naturally occurring; therefore, the true background in the SRPA should be zero.

Forty of the 41 wells in the vicinity of CFA have been sampled for trichloroethene at least once. Data indicate that trichloroethene was detected on eight of the 40 wells. Wells; USGS 34, 38, and 77 are located upgradient from CFA. Four wells in which trichloroethene was detected are located within CFA, CFA-1, CFA-2, LF2-08, and LF2-09. The remaining well which has detected trichloroethene was detected in, located downgradient of CFA, near the RWMC.

A total of eight wells are routinely sampled at CFA for trichloroethene. However, only two of these routinely monitored wells (LF2-08 and LF2-09) have detected trichloroethene. Wells CFA-1 and CFA-2 were sampled three times between 1987 and 1993 and detected trichloroethene was detected in all samples. These wells have been sampled since. Trend analysis indicate that trichloroethene concentrations in well LF2-08 and LF2-09 have decreased to below the detection limit since July 1996 and October 1996, respectively (Burgess, 1998).

A total of four wells are routinely sampled for trichloroethene upgradient of CFA. All but one of these have trichloroethene above the detection limit. However, all concentrations from these three wells, USGS 34, 38, and 77 were at the detection limit of 0.2 ug/L. Trend analysis for all three wells indicate concentrations remained below the detection limit until the October 1995 sampling event.

Present groundwater concentrations indicate, as stated above, that trichloroethene presently exists in wells upgradient from CFA (Figure 4-36). Therefore, based on these groundwater data and trend analysis, source(s) for trichloroethene could be located at CFA, upgradient of CFA, or both. However, based on the overall higher concentrations detected in wells at CFA verses concentrations in upgradient wells, this would strongly suggest a CFA source(s). If the source(s) were upgradient of CFA, the



CFA. Four wells at CFA are routinely monitored for tritium, CFA-1, CFA-2, LF2-10, LF3-09, and LF3-11 (annually). All 21 of the wells located between INTEC and CFA are routinely sampled for tritium.

Of the 41 wells, only four have never detected tritium above the detection limit including; CFA-MON-A-001, STF-MON-A-01A, STF-MON-A-02A, and the badging facility well.

Twenty-three of the 37 wells which have tritium have had concentrations above the MCL. All 37 of these wells have had concentrations above the background level and the risk based concentration. The latest tritium concentration data as compared to MCLs, background, and risk based concentration is illustrated in Table 4-3. This table lists wells in which the latest sample concentration exceeds one or all of the following; MCL, background, and risk based concentration for tritium in the groundwater.

Trend analysis for tritium concentrations for most wells in the vicinity of CFA indicate an overall decrease throughout their sampling history (Burgess, 1998). However, wells USGS 35 and 104 indicate an overall increasing concentration. Concentration trends in most wells since 1993 are relatively flat or slightly decreased. However, some wells do indicate a slight increase in concentration trends since 1993 including; CFA-1, LF2-08, LF3-08, M7S, USGS 35, 39, and 104. 1996 tritium concentration diagrams illustrate the highest concentrations are located in wells immediately downgradient of INTEC (Figure 4-37). However, two distinct tritium plumes occur; one located near wells immediately south of INTEC and the other located near wells at CFA. This figure was generated using a kriging package. The reason the software illustrates two distinct plumes is because of the lack of wells between these well groups. If wells were located between these groups there would most likely be one continuous tritium plume, originating at INTEC and moving downgradient through the CFA area.

Groundwater model predictions from the WAG 3 RI/FS (Schafer et al., 1996) indicate that tritium, originating from INTEC significantly affects the CFA area. Their model simulations began in 1959 and continued through 2095. According to their modeling predictions tritium concentrations above the MCL and background levels will be present at CFA between 1992 and 2025. Risk based concentrations ( $10^{-6}$ ) will exist in the CFA area between 2025 and 2063. Schafer et al., (1996) suggested the peak concentration in the aquifer at INTEC was  $2.6 \times 10^6$  pCi/L in 1960. Comparisons of model predicted concentrations to aquifer field data are very close to measured values in most wells. This is to be expected given the excellent vadose zone matches and the fact that their aquifer model was calibrated to the tritium field data.

Modeling efforts, groundwater data, and trend analysis all indicate the significant source of tritium being located at INTEC/TRA. It is possible that sites at CFA contribute tritium to the aquifer, however these concentrations are minimal compared to those originating from upgradient sources. The only possible site from which tritium would have been discharged at CFA would be the STP Drainfield, which discharged treated effluent from the plant to the subsurface. Tritium-contaminated water, which was pumped from the aquifer at the CFA production wells, was discharged to the drainfield after treatment at the STP. There are no known process at CFA that would have generated additional tritium.

**4.3.1.2.18 Uranium-234.** The MCL is for uranium-234 is 13.9 pCi/L. The background level in the SRPA has not been established. The risk based concentration ( $10^{-6}$ ) is 1.07 pCi/L.

**Table 4-3.** Tritium data for wells in the vicinity of CFA.

| Well        | Last Sample | Concentration of Last Sample (pCi/L) | Does Sample Exceed Background Level? (150 pCi/L) | Does Sample Exceed MCL? (20,000 pCi/L) | Does Sample Exceed 10 <sup>-6</sup> Risk Based Level? (666 pCi/L) |
|-------------|-------------|--------------------------------------|--|--|---|
| CFA-1       | 7/96        | 18,800                               | YES  | NO                                     | YES   |
| CFA-2       | 7/96        | 14,100                               | YES  | NO                                     | YES   |
| CFA-MON-002 | 7/95        | 1,970                                | YES  | NO                                     | YES   |
| EOCR        | 10/74       | 1,000                                | YES  | NO                                     | YES   |
| LF2-08      | 5/95        | 21,000                               | YES  | YES                                    | YES   |
| LF2-09      | 10/93       | 25,000                               | YES  | YES                                    | YES   |
| LF2-10      | 4/96        | 2,900                                | YES  | NO                                     | YES   |
| LF2-11      | 8/95        | 24,000                               | YES  | YES                                    | YES   |
| LF3-08      | 5/95        | 25,200                               | YES  | YES                                    | YES   |
| LF3-09      | 7/96        | 22,300                               | YES  | YES                                    | YES   |
| LF3-10      | 8/95        | 17,600                               | YES  | NO                                     | YES   |
| LF3-11      | 10/93       | 16,000                               | YES  | NO                                     | YES   |
| M7S         | 4/97        | 1,430                                | YES  | NO                                     | YES   |
| "MORE"      | 4/95        | 1,300                                | YES  | NO                                     | YES   |
| SITE-09     | 7/96        | 200                                  | YES  | NO                                     | YES   |
| USGS 20     | 4/96        | 7,400                                | YES  | NO                                     | YES   |
| USGS 34     | 4/96        | 3,800                                | YES  | NO                                     | YES   |
| USGS 35     | 4/96        | 6,100                                | YES  | NO                                     | YES   |
| USGS 36     | 7/96        | 5,200                                | YES  | NO                                     | YES   |
| USGS 37     | 4/96        | 12,000                               | YES  | NO                                     | YES   |
| USGS 38     | 4/96        | 14,200                               | YES  | NO                                     | YES   |
| USGS 39     | 7/96        | 4,800                                | YES  | NO                                     | YES   |
| USGS 77     | 4/96        | 25,100                               | YES  | YES                                    | YES   |
| USGS 85     | 4/96        | 7,900                                | YES  | NO                                     | YES   |
| USGS 104    | 10/96       | 1,760                                | YES  | NO                                     | YES   |
| USGS 106    | 10/96       | 1,400                                | YES  | NO                                     | YES   |
| USGS 111    | 4/96        | 7,500                                | YES  | NO                                     | YES   |
| USGS 112    | 7/96        | 13,400                               | YES  | NO                                     | YES   |
| USGS 113    | 7/96        | 10,800                               | YES  | NO                                     | YES   |
| USGS 114    | 7/96        | 22,400                               | YES  | YES                                    | YES   |
| USGS 115    | 7/96        | 4,800                                | YES  | NO                                     | YES   |
| USGS 116    | 7/96        | 3,800                                | YES  | NO                                     | YES   |